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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in Devices for Purifying Internal Combustion Engine Exhaust Gases containing Solid Particles

We, AUTOMOBILES M. BERLIET, a French Corporation, of 30, Quai Claude Bernard, Lyon (Rhône) France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with devices for purifying internal combustion engine exhaust gas containing solid components. Some internal combustion engines, particularly Diesel or compression-ignition engines release exhaust gas containing, in addition to relatively small amounts of gaseous combustion products such as carbon monoxide, nitrogen oxyde, aldehydes and organic acids, various elements still in the solid state of which soot is the main component, especially when considerable amounts of fuel are injected. This soot, resulting from the cracking of the fuel hydrocarbons, consists of very small particles and has a very large specific surface area of the order of 200 or 300 sq. m./gram, whereby it can adsorb aromatic polycondensates and other organic compounds such as 3.4-benzoypyrene for example, of which the cancer-producing activity is well known.

Therefore the problem of purifying the exhaust gas of Diesel engines consists primarily in removing the soot therefrom. More particularly, it consists in removing, from a hot gas stream having a continuously varying output which at times may be as high as several cubic metres per minute, relatively small amounts of solid, extremely small particles of the order of 0.3 to 1μ, in amounts varying from 0.1 to 3 grams per cubic metre of exhaust gas.

Known catalytic processes proposed heretofore for purifying Diesel engine exhaust gases consist in causing the exhaust gas stream to flow through a fluidized layer of an oxidation catalyst carried by a granular-type support. Therefore, purifying apparatus designed for carrying out these methods are efficient only as far as the catalytic treatment of gaseous products is concerned, the soot filtering action being very moderate, of the order of 5%.

It is an object of the invention to provide an improved device adapted to purify exhaust gas containing solid components, this device being effective both on the solid components and on the noxious gaseous products of the gas.

According to this invention a gas purifying device comprises a filter element of alumina-silica ceramic fibres and adapted to retain solid components of exhaust gas passing through the filter element, the fibres being impregnated with an oxidation catalyst of a type capable of igniting noxious gaseous components of the exhaust gas at their input temperature so as to eliminate by combustion solid components retained by the filter element.

More particularly, any catalyst adapted to initiate the conversion of noxious gaseous components of the exhaust gas at a temperature ranging from 170°C to 200°C may be used to advantage. These temperature requirements are easily met due to the inherent temperature of the exhaust gas, inasmuch as the purifying device may be mounted in the vicinity of the engine, although adequate lagging of the exhaust pipe may be contemplated, if necessary, for example when the device is spaced several metres from the engine.

Under the conditions set forth above the soot content is ignited almost continuously due to the ignition of the gaseous components and the increase in temperature

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due to their combustion, thus avoiding clogging of the filter element and making it unnecessary to clean or replace same after a certain period of operation. It may also be noted that if this filter element happened to be partially clogged, the catalyst will neverthless continue to efficiently treat the gaseous components, due to its very nature and to its considerable distribution surface area.

Moreover, this device is adapted to act not only as a filter and catalytic cleaner but also as an exhaust silencer of high sound-damping capacity in that in a preferred embodiment the exhaust gas purifying device of this invention will consist of an exhaust silencer in which the filter constitutes an inner sleeve through which the exhaust gas must forcibly flow before escaping from the silencer.

The alumina-silica ceramic fibres constitute a material particularly suitable for the intended purpose and, when used in the form of long staples (10") having a diameter of about 3μ (more exactly 2.8μ), have proved to be entirely satisfactory. The material known under the trade name "Kaowool", which is an alumina-silica ceramic fibre, is particularly suitable.

The catalyst may consist of finely divided platinum such as platinum black or sponge. More particularly, the catalyst may be formed *in situ* by impregnating the alumina-silica ceramic fibres with a platinum chloride solution to which amonia is added, the mixture being subsequently calcinated to obtain the desired deposit according to the known method.

The alumina-silica ceramic fibres may be impregnated with this solution by immersion or by brush coating.

Of course, any other method of incorporating this catalyst into the fibres may be used.

A specific form of an exhaust gas purification device in accordance with the invention will now be described by way of example, with reference to the accompanying drawing, in which:—

Figure 1 is an axial section of the scrubbing device; and

Figure 2 is a cross-section on line II-II of Figure 1.

The device illustrated comprises an exhaust silencer casing 1 provided with an inlet pipe 2 and an outlet pipe 3 for the exhaust gas. The inlet pipe 2 is carried by a cover 4 bolted in a fluid-tight manner on the casing 1 by means of bolts 6, a sealing gasket 5 being interposed therebetween.

Secured to the cover 4 and extending into the inner chamber of casing 1 is a hollow cylindrical body consisting of two concentric cylindrical grids 7 and 8 made of fine stainless steel wire-mesh material. Enclosed and retained in the annular space formed between these two grids 7 and 8 is a filter layer 9 of alumina-silica fibres impregnated with a catalyst, as already explained.

The two grids of stainless steel wire mesh 7 and 8 are welded to a bottom plate 10 closing completely the central gas passage 11 as well as the annular space formed between the two grids. This bottom also acts as a means for centering the filter element and bears against the inner wall of the casing 1. Peripheral notches 12 permitting a sufficient gas flow are formed in the bottom plate 10.

The device is surrounded by a lagging 13, of for example asbestos cloth, adapted in turn to be protected from shock by a metal case (not shown).

This device operates as follows:—

As a silencer:—

The central exhaust gas passage 11 constitutes a particularly efficient absorption-type expansion chamber.

As a filter:—

The diameter of the expansion chamber 11 may easily be so selected that the surface area of the inner cylindrical wall thereof provides a large cross-sectional area for the passage of exhaust gas, the thickness of the filtering layer 9 being also such that when the gas is fed through the inlet pipe 2 it flows through this layer and deposits therein nearly all the soot, contained in the gas, even in case of maximum exhaust gas output (with the engine operating at top speed). It may be noted that as the gas flows from the innerface of the filter layer to the outer periphery thereof it contacts a gradually increasing filtering surface area, thus promoting settling of soot. The general dimensions of the device are dependent of course on the cubic capacity of the engine of which the exhaust gases are to be purified. For example, with an 8,000 c.c. Diesel engine revolving at 2,100 rpm under maximum power output conditions, a device according to this invention having a length of 106 cm and a diameter of 33 cm. and containing a filtering layer of 45 cubic decimeters proved to be completely satisfactory. As to the

$$\frac{\text{length}}{\text{diameter}}$$

ratio of the filter layer, practical tests proved that as this ratio approached unity the operation of the device as a purifier became intermittent, the ignition becoming more uncertain.

As a purifier:—

In addition to its role as a soot-retaining filter, the layer of alumina-silica ceramic fibers acts by virtue of the impregnating

catalyst, upon the combustible gaseous products contained in the exhaust gas. This catalyst, as already explained, reduces the ignition temperature of the noxious gaseous combustible products, thus enabling them to be ignited by the heat contained in the exhaust gas. To this end, the central disposition of the gas inlet passage makes it possible to recover the maximum quantity of heat contained therein. It will be noted that in the case of Diesel engines the oxygen necessary for supporting the combustion is contained in the exhaust gas; in other cases the air may be drawn from the surrounding atmosphere. When the gas is ignited the soot contained in the filter is ignited in turn.

The filter is thus cleaned completely without requiring any external intervention. This ignition takes place at times during the operation of the vehicle, for example each time the temperature exceeds 200°C at the input end of the device, which is a frequent if not a continuous occurrence.

The filter elements may take other forms. For example, two bags of different cross-sectional dimensions and of the same length, made from fireproof cloth such as asbestos fabric woven to have a relatively wide-mesh texture, may be used, these bags being mounted one within the other and providing therebetween an annular space filled with the alumina-silica ceramic fibres impregnated with the catalyst, the assembly being held in position in the silencer casing by means of refractory steel rods.

WHAT WE CLAIM IS:—

1. A device for purifying internal combustion engine exhaust gas containing solid components the device comprising a filter element of alumina-silica ceramic fibres and adapted to retain solid components of exhaust gas passing through the filter element, the fibres being impregnated with an oxidation catalyst of a type capable of igniting noxious gaseous components of the exhaust gas at their input temperature so as to eliminate by combustion solid components retained by the filter element.

2. A device according to claim 1, wherein the fibres are long-staple fibres having a length of about 10″ and a diameter of about 3μ.

3. A device according to claim 1 or claim 2, wherein the catalyst is selected to ignite the noxious gaseous components at temperatures of from 170°C to 200°C.

4. A device according to claim 2, wherein the catalyst is finely divided platinum, for example platinum black or sponge.

5. A device according to claim 4, wherein the catalyst is formed *in situ* by impregnating the fibres with platinum chloride solution to which ammonia is subsequently added, the mixture being subsequently calcined.

6. A device according to claim 1, comprising a filter element in the form of a sleeve inserted in an exhaust silencer, and forming with the casing of the silencer an annular space, exhaust gas being introduced into the sleeve and passing through the walls thereof into the annular space.

7. A device for purifying exhaust gas substantially as herein described, with reference to the accompanying drawings.

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1 SHEET

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This drawing is a reproduction of the Original on a reduced scale.

Fig. 2

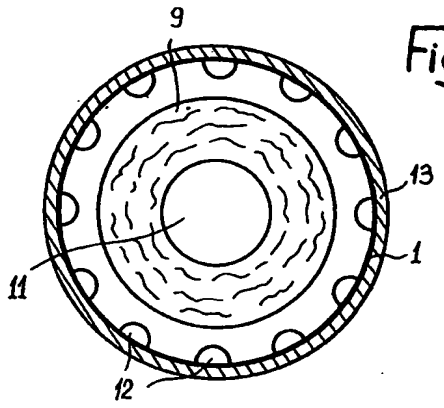
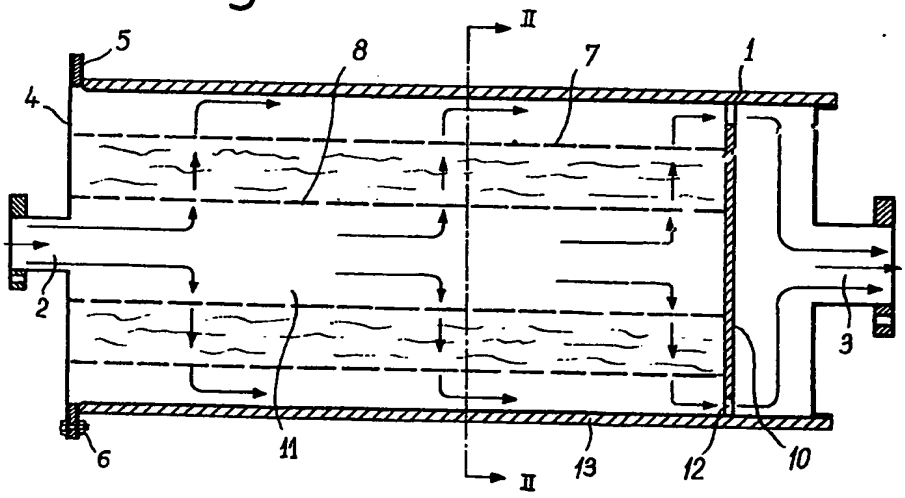


Fig. 1



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